

AFMC LSO/LOP
5215 THURLOW ST
WRIGHT-PATTERSON AFB OH
45433-5540
FAX: 937-656-1350
PHONE: 937-257-3362

PACKAGING PERFORMANCE TESTING
OF A CLEATED PLYWOOD BOX WITH SKIDS (38 IN. BY 38 IN. BY 38 IN.), CONTAINING 331 LB OF
SOLID
HAZARDOUS MATERIALS - PACKING GROUP I

ALL TRANSPORTATION MODES

Date: September 1, 2004

AFPTEF PROJECT NUMBER: 04-P-101
POP TEST ID NUMBER: DODPOPHM/USA/DOD/AF69/DLA-W005

Part 1.

A. Title: PACKAGING PERFORMANCE TESTING OF A CLEATED PLYWOOD BOX WITH SKIDS (38 IN. BY 38 IN. BY 38 IN.), CONTAINING 331 LB OF SOLID HAZARDOUS MATERIALS - PACKING GROUP I

Report Number: DLA-W005

AFPTEF Project Number: 04-P-101

Manhours: 40

Report Type: FINAL

B.

TEST REPORT APPLICABILITY STATEMENTS see section 2E.

Report Prepared by:

SIGNED

SUSAN J. EVANS

Mechanical Engineer

Approved by:

SIGNED

MICHAEL WERNEKE

Chief, Transportation & Pkg Policy Branch

SIGNED

ROBBIN L. MILLER

Chief, AF Packaging Technology and Engineering

Testing Completion Date: 31 August 04

Approved for Publication and Dated: 1 September 04

Responsible Individual: Robbin L. Miller

Performing Activity: AF Packaging Technology and Engineering Facility

AFMC LSO/LOP

5215 Thurlow St

WPAFB OH 45433-5540

Specific Authority: Distribution Statement F. Further dissemination only as directed by AFMC LSO/LOP or higher DoD authority.

Requesting Organization: Defense Distribution Center

DDC-J-3/J-4-0

ATTN: POP Team

2001 Mission Drive

New Cumberland PA 17070

Part 2. Data Sheet**A. Exterior Shipping Container****UN Type:** Plywood box**UN Code:** 4D**NSN:** NA**Specification Number(s):** ASTM D 6251, Type II or III, Class 2, Style A1 (formerly PPP-B-601 Style A)**Container Manufacturer:** AFMC LSO/LOP**Date of Manufacture:** August 2004**Material:** Exterior grade plywood (nom. 11/32 in. thickness); pine lumber for cleats and skids.**Container Specification Dimensions:** 38.0 in. x 38.0 in. x 38.0 in. ID.**Container Outer Dimensions:** 40.25 in. x 40.25 in. x 43.5 in. OD.**Closure (Type/Method):** ASTM D 6251, IAW Style A1 nailed top; additional steel strapping IAW ASTM D 6251, S2.**Strapping Specification Number(s):** ASTM D3953, Type I, Class A or B, minimum 16 mm (3/4-inch) width and minimum thickness of 0.46 mm (0.018 in.).**B. Inner Contents of Container****Type:** Polyethylene bag, 4 or 6 mil thickness**NSN:** N/A**Manufacturer Stock Number:** Hazmatpac B790AS**Capacity:** 75 cubic feet**Dimensions:** Minimum dimensions 40 in. x 36 in. x 90 in.**Closure (Method/Type):** Seal with fiber reinforced tape.**Tape Specification:** A-A-1687 Fiber Reinforced Tape, 1-inch.**Tape NSN:** 7510-00-582-4772.**Reinforcement Specification Number(s):** NA.**Absorbent Material Description:** NA.**Additional Description:** NA.**Loading of container (see Figures 1, 2, and drawing).**

1. Line the container with a 4-mil or 6-mil (preferable) polyethylene bag, with minimum dimensions 40 in. x 36 in. x 90 in., and drape excess liner material over the top edge of box to hold it in place while filling.

2. Load solids into lined box. Block and brace solids with fiberboard pads (SW, 200 psi) to assure a tight fit between box sides, bottom and lid (use 4-lb or greater density polyethylene foam and/or blocks of wood to tightly fill large internal spaces). Pull upper edges of liner material together, and either fold down the plastic liner and tape closed using 1-inch fiber-reinforced nylon tape; or twist the gathered liner to close and secure with a 12-inch minimum length of 1-inch fiber-reinforced nylon tape. Excess air should be pressed out of the liner as it is gathered together to prevent it from "puffing up" and interfering with closing the box. Box load should be in tight, continuous contact with all inner faces of the box on closure. See Figure 1.

3. Place lid on box and close IAW 2A. See Figure 2.

C. Actual Product: Not Used**NSN:** N/A**Specification:** Unknown**UN/DOT/IMO/IATA Proper Shipping Name:** Unknown (likely use is large truck batteries)**United Nations Code Number:** Unknown**United Nations Packing Group:** Unknown**UN Hazard Class:** Unknown **DOT Hazard Class:** Unknown**IMO Hazard Class:** Unknown **IATA Hazard Class:** Unknown**Physical State:** SOLID**Items per container:** Various**Gross Mass/Weight:** 205.02 kg (452 lb)**Item Mass/Weight:** Not to exceed 150.1 kg (331 lb)**Density/Specific Gravity:** N/A

Drop Height: 1.8 m (71 in.)
Stacking Weight/Force Required: 351.6 kg (774 lb)
Additional Description: NA.

D. Test Product: Used

Name: Boxed paper, fiberboard, wood.
United Nations Packaging Group: N/A
Physical State: Solid
Items per outer container: Various
Gross Mass/Weight: 205.02 kg (452 lb)
Test Item Weight: 150.1 kg (331 lb)
Test Item Dimensions: N/A
Density/Specific Gravity: NA
Drop Height: 1.8 meters (31.5 in.)
Stacking Weight/Force used: 725.7 kg (1600 lb)
Additional Description: N/A

E. Test Applicability- See test results in Part 6.

(1) Tests documented herein are design qualification. It is the responsibility of the government shipper/certifier to fully verify design compliance and packaging material quality.

(2) Drop testing performed herein was tested in accordance with DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A. This joint DoD policy document allows packaging to be drop tested more than once provided the packaging continues to pass the 49CFR 178.603 requirements. Questions about or clarification of this policy can be sought from the respective preparing activities of the regulation.

(3) DoD contractor use of this test report or its resultant certifying mark only with the permission of the testing activity AND as specified in DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A.

(4) Pass/fail conclusions were based on the particular specimens, both inner and outer containers, and quantities of each submitted for test. Extrapolation to other manufacturers, applications, commodities, inner containers, container sizes, or lesser internal quantities is the responsibility of the packaging design agency or applicable higher headquarters and the limitations documented in 49CFR. Extrapolation of test results based on lesser than minimum UN/DOT required test specimens is also the responsibility of the packaging design agency or applicable higher headquarters.

(5) Reference to specification materials has been made based on one of the following methods: supplied by AFPTEF, provided by the requester, markings printed on, attached to or embossed on the packaging.

(6) Testing performed in accordance with 49CFR 170-180, except as documented in this report.

(7) Performance testing was undertaken and completed at the request of an agency responsible for management of the dangerous good(s). The completion of successful UN/DOT testing does not, by itself, authorize the marking and transportation of the dangerous good(s). Applicable modal regulations should be consulted concerning the relationship of performance testing completed and the dangerous good(s).

(8) The DOT performance tests are intended to evaluate the performance of the entire packaging configuration's ability to prevent the release of contents during conditions normally incident to transportation. The criteria used to evaluate container system performance is whether the contents of the packaging are retained intact. The successful completion of the recommended tests does not ensure undamaged delivery.

(9) Tests performed and documented, herein, in no way verify Government supplier's operations (included but not limited to: internal procedures, suppliers, or manufacturing processes) comply with the DOT's or international's regulations. The testing facility has no knowledge and assumes no knowledge, that specific material testing requirements (i.e. plastics - only allowed to use regrind from the same operation; specific vendor plastic formulations including quantity of carbon black, ultra-violet inhibitors or pigments, or production run's individual leakproofness tests) are or were performed by the manufacturer(s) listed herein, unless otherwise noted in the report.

Part 3. Introduction.

Brief description of why specific tests were performed and rationale for the test product selected (if applicable).

Packing Group I testing was requested on the above stated configuration. For lesser quantities, variations to testing requirements can be found in 49 CFR, part 178.601(g). This configuration is intended for all transportation modes.

Boxed paper, fiberboard and wood were used as a substitute for the actual item as permitted by 49 CFR part 178.602(c).

Each packaging was subjected to appropriate drop and vibration testing as prescribed by ASTM D 4919. These tests are designed to simulate the shock and vibration a package configuration may encounter during conditions normally incident to transportation. The order of testing was the stacking test followed by the vibration test and the drop test.

The use of one sample packaging configuration for multiple tests and drops is DoD policy as stated in DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A. This option was exercised in this test as noted in Part 6.

Part 4. Tests Required/Performed (as applicable).

NOTE: Packagings fabricated from fiberboard, paperboard, or paper, including composite containers with outer fiberboard containers, should be conditioned for a minimum 24 hours prior to any testing. Standard conditions $23 \pm 3^{\circ}\text{C}$ ($73 \pm 4^{\circ}\text{F}$) and $50 \pm 2\%$ relative humidity apply.

A. Leakproofness test. 3 outer containers each individually tested for 5 minutes (30 minutes for plastic containers). **Not applicable.**

B. Hydrostatic Pressure Test. 3 outer containers each individually tested for 5 minutes at 100 kPa (15 psig). **Not applicable.**

C. Stacking Test. One test per outer container, 3 containers required. Compression by a top load is calculated to simulate a stack height of 3 meters, maintained for 24 hours. **NOTE:** If only one configuration sample is tested, test duration shall be 72 hours.

Static weight. Apply the calculated weights using a constant load evenly over the entire container.

$$M = \frac{m(3000-h)}{h}$$

where: m = container's gross mass (as shipped) in kilograms = **205.02 kg**

h = container's height in millimeters = **1104.9 mm** (effective height for container in stack)

M = constant load mass in kilograms = **351.6 kg**

or:
$$W = \frac{w(118-h)}{h}$$

where: w = container's gross weight (as shipped) in pounds = **452 lb**

h = container's height in inches = **43.5 in.** (effective height for container in stack)

W = constant load weight in pounds = **774 lb**

NOTE: Where the contents of the test sample are non-dangerous liquids with relative density different from that of the liquid to be transported, the force shall be calculated in relation to the latter.

Information - This test assumes similar weight containers stacked on top of the test sample. This may or may not be a valid assumption. This calculation also only provides a minimum weight. Consideration should be given to what will actually be experienced in the transportation cycle.

D. Vibration Test (domestic requirement). One test per container, total of three test specimens.

The test shall be performed for 1 hour at a frequency that causes the package to be raised from the vibrating platform to such a degree that a piece of material approximately **0.2 cm** (1/16 in.) thickness can be passed between the bottom of the package and the platform. The vibrating platform shall have a vertical double-amplitude (peak-to-peak) displacement of **2.54 cm** (1 in.). Perform tests in accordance to 49CFR 173 Subpart B, Appendix C and 49 CFR 178. **NOTE:** If only one configuration sample is tested, test duration shall be 3 hours.

E. Drop Test. 5 drops in order: flat on the bottom, top, long side, short side and top corner. The drop height shall be appropriate for the packaging group of the commodity. The container shall strike a target which shall be a rigid, non-resilient, flat, and horizontal surface. For other than flat drops, the center of gravity shall be vertically over the point of impact. **NOTE:** All drops may be made on one sample. If the sample fails after drops 2 through 5, it may be replaced by another sample identically loaded.

1. Solids and liquids, if the test is performed with the actual contents to be carried, or with another substance having essentially the same characteristics, or for liquids if the test is performed with water and the intended contents has density less than 1.2 g/cm³ (specific gravity less than 1.2) the drop height shall be:

<u>Packing Group</u>	<u>Drop Height</u>
I	1.8m (70.9 in.)
II	1.2m (47.2 in.)
III	0.8m (31.5 in.)

2. Where the test sample doesn't contain the intended contents and its specific gravity is greater than 1.2, then obtain the required drop height in meters by calculating the following with product density (d):

<u>Packing Group</u>	<u>Drop Height</u>
I	(d) x 1.5m ((d) x 59.1 in.)
II	(d) x 1.0m ((d) x 39.4 in.)
III	(d) x 0.67m ((d) x 26.4 in.)

Round the drop height up to the first decimal.

F. Fiberboard Water Resistance (Cobb) Test. One test per fiberboard specimen, total of ten.

Strong, solid or double faced corrugated fiberboard (single or multi-walled) must be used, appropriate for the capacity and the intended use of the box. The water resistant outer surface must not increase in mass greater than **155 grams per meter² (0.0316 pounds per foot²)** after 30 minutes in accordance with International Standards Organization (ISO) 535 or Technical Association of the Pulp and Paper Industry (TAPPI) T441 or ASTM D 3285. Five individual fiberboard specimens shall be exposed on the wire side and five on the felt side. **Not applicable.**

Part 5. Criteria for Passing Tests.

A. Leakproofness Test. Any leakage is cause for rejection. **Not applicable.**

B. Hydrostatic Pressure Test. Any leakage is cause for rejection. **Not applicable.**

C. Stacking Test.

No test sample shall leak. Composite and combination containers shall not exhibit leakage of the filling substance from the inner receptacle or container. No test sample shall show deterioration which adversely affects transportation safety or show any distortion liable to reduce its strength, cause stacking instability, or cause damage to internal container components likely to reduce transportation safety.

D. Vibration Test.

No rupture or leakage from any of the packages. No test specimen shall show any deterioration which could adversely affect transportation safety, result in possible discharge of contents or reduce packaging strength.

E. Drop Test.

Each packaging containing liquids shall be leakproof when internal and external pressures are equalized. Composite and combination containers shall not exhibit damage to the outer packaging likely to adversely affect transportation. In addition, the inner packaging shall not leak into the filling substance or lading.

F. Fiberboard Water Resistance Test.

The calculated water absorption of all samples shall be less than **155 g/m²**. **Not applicable.**

Part 6. Discussion and Test results.

Narrative description of test results, including any rationale for variations. For each packaging to pass, all applicable tests must be performed and pass criteria listed herein.

A. Leakproofness Test. Not applicable.

B. Hydrostatic Pressure Test. Not applicable.

C. Stacking Test. Pass

Duration: 72 hours at ambient conditions.

One loaded container was stacked with 1600 lb for 72 hours. There was no damage to the container which could result in damage to the inner item, no crushing, nor stack instability. No other adverse results were noted. See Figure 3

D. Vibration Test. Pass

Duration: 3 hours at ambient conditions.

The same packaging used in the stacking test was vibrated on an electro-hydraulic vibration table which was set at 1-inch vertical double amplitude (peak-to-peak) displacement, at a frequency such that the packaging was raised from the platform. The distance was measured using a 1/16-inch feeler gage. At approximately 4.34 Hz the feeler gage could be passed between the bottom of the package and the table surface. There was no damage to the outer container that would be likely to cause leakage from, or weakening of, the package during transportation. See Figure 4.

E. Drop Test. Pass

Tested at ambient conditions.

The packaging was dropped 1.8 meters onto the required four flat sides and a top corner. Although there was minor crushing/splintering of the impact corner, there was no damage to the container that would be likely to cause leakage from, or weakening of, the package during transportation. See Figures 5 and 6.

F. Water Resistance (Cobb) Test. Not applicable.

Part 7. Performance Marking on Container:

The container specified herein passes the DoT and international regulatory requirements to the extent tested. Equivalent DoD built or grandfathered containers MAY also qualify for the following marking as directed by DoD policy documents.

**Part 8. References**

- A. 49CFR 170-180
- B. DLAD 4145.41/AR 700-143/AFJI 24-210/NAVSUPINST 4030.55A/MCO 4030.40A - Packaging of Hazardous Materials
- C. ISO 535/TAPPI T 441/ASTM 3285 - Determination of Water Absorption of Paper and Board (Cobb Method)
- D. ISO 3574 - Cold-reduced carbon steel sheet of commercial and drawing quantities.
- E. ASTM D999 - Methods for Vibration Testing of Shipping Containers.

Part 9. Distribution List

Commander
 Defense Logistics Agency
 DDC-J-3/J-4-0
 ATTN: Linda McCarthy
 2001 Mission Drive
 New Cumberland PA 17070

AFMC LSO/LOP
 Project Folder



Figure 1. Test load in box.



Figure 2. Closure of wood box.



Figure 3. Stack test.



Figure 4. Vibration test.



Figure 5. Drop test.

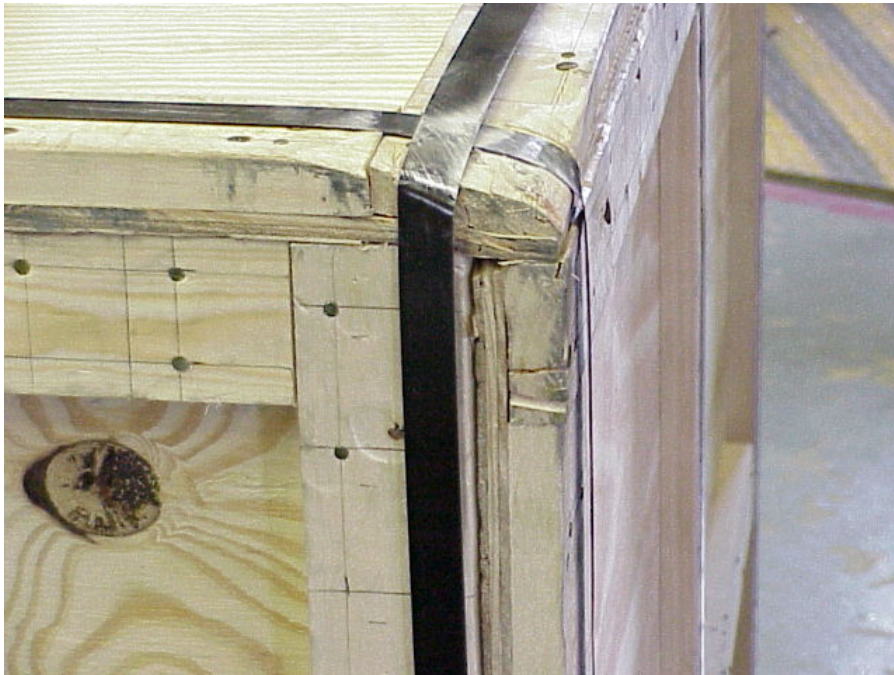


Figure 6. Minor test damage, impact corner.

